Proposed Aerosol Treatment for CAM4

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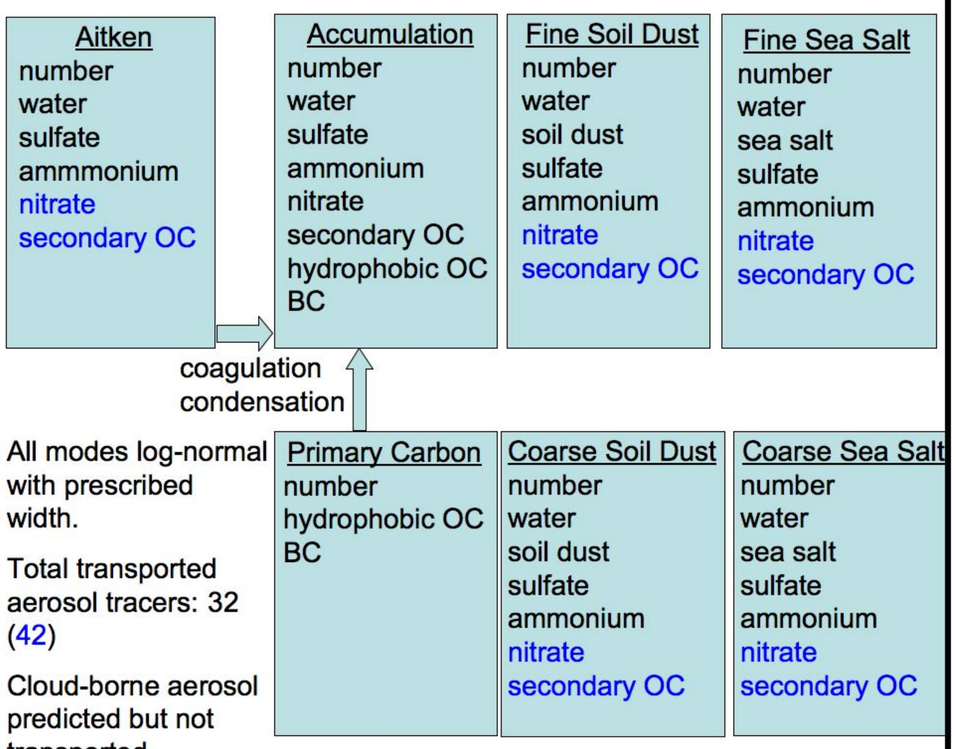
Goal: Develop a complete and computationally efficient representation of the aerosol for exploring the competing and complementing mechanisms by which natural and anthropogenic aerosols influence clouds and the cycles of water and energy.

Current Aerosol Treatment in CAM

sulfate	hydrophobic black carbon	sea salt 1	soil dust 1
ammonium	hydrophobic organic carbon	sea salt 2	soil dust 2
nitrate	hydrophilic black carbon	sea salt 3	soil dust 3
secondary organic carbon	hydrophilic organic carbon	sea salt 4	soil dust 4

Proposed Benchmark Aerosol Treatment for CAM4



Process and Property Treatment

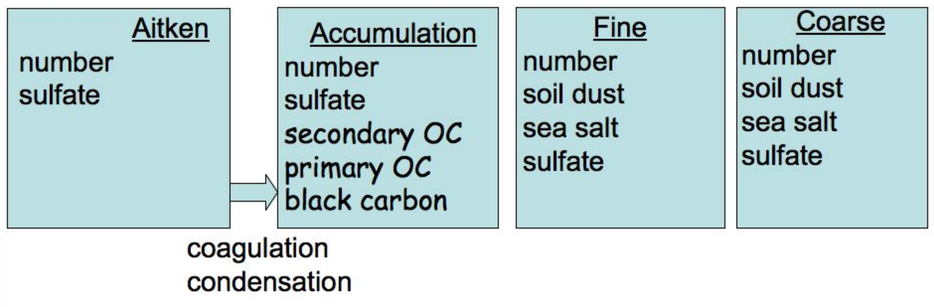
- Primary emissions: size-resolved.
- New particle formation: ternary homogeneous nucleation.
- VOC oxidation and condensation separated.
- Condensation: mass transfer theory.
- Cloud chemistry: current CAM3 treatment (pH dependent)
- Coagulation: Brownian within, between modes.
- Intermode transfer due to condensation, coagulation, and cloud chemistry.
- Scavenging: in-cloud -- activation of number and mass for each mode, number depletion by droplet collision/coalescence; below-cloud -- by impaction.
- Water uptake: Kohler theory for internal mixture, with hysteresis dependent on previous aerosol water.
- Optical properties: parameterization in terms of wet refractive index and wet surface mode radius.

Weaknesses of Current Treatment

- Aerosol species are externally mixed (individual particles are composed of only a single species).
- Their size distribution is prescribed (number is diagnosed from the predicted mass).
  - –Processes that should only affect mass (condensation, chemistry) also affect number.
  - –Processes that only affect number (nucleation, coagulation) are neglected.
- Hydrophobic carbon ages to hydrophilic with prescribed timescale

Proposed Simple Aerosol Treatment for CAM4

Assume aerosol are hydrated for RH > crystalization RH.
Carry soil dust and sea salt in same mode because sources are separate.
Assume primary carbon is internally mixed with secondary aerosol.
Assume ammonium neutralizes sulfate, and neglect nitrate.



All modes are log-normal with prescribed width.
Total transported aerosol tracers: 15
Cloud-borne aerosol is predicted but not transported.

Simulation Configurations

- Benchmark modal present day
  - –On-line oxidants
  - –Off-line oxidants
- Benchmark modal pre-industrial
  - –On-line oxidants
  - –Off-line oxidants
- Simplest modal present day
- Simpliest modal pre-industrial
- Offline benchmark present day
- Offline benchmark pre-industrial